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METHOD OF FORMING COLOR EFFECTS IN HYDROGEL CONTACT LENSES AND OPHTHALMIC PROSTHESES

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ABSTRACT OF THE DISCLOSURE

Object of the invention is a method of forming color effects in hydrogel contact lenses and ophthalmic prostheses, wherein the colored pattern is formed between at least two transparent hydrogel layers, bound together by polymerizing between them a monomer mixture forming the same or similar hydrogel. A homogeneous transparent thin covering layer of hydrogel is first formed on a regular surface of a smooth pad. The desired colored pattern is then formed between it and the concave surface of a lens or that of an ophthalmic prosthesis, being either laid between them as a thin foil or created on either the said concave surface or said covering layer, the last mentioned embodiment being preferred. The bond between the lens or prosthesis and the covering layer is realized by putting a drop of initiated monomer mixture between them and pressing them slightly together so that the excess of the monomer mixture is expressed. The colored pattern is preferably formed using colors, dyestuffs or pigments which are insoluble in water and in monomer mixture. The finished lens or prosthesis is then removed from the pad by swelling the whole in a swelling liquid such as water or alcohol and kept in sterile physiologic solution.

REFERENCE TO COPENDING APPLICATIONS

In French Pat. No. 1,499,774 (U.S. patent application No. 673,026, which is a continuation-in-part application to the application No. 593,643, filed Nov. 14, 1966 now abandoned), there is disclosed a method for manufacturing colored hydrogel contact lenses and ophthalimc prostheses, wherein a mixture of ethylene glycol monomethacrylate with a little ethyleneglycol dimethacrylate is polymerized in a mold rotating about an axis perpendicular to a spherically concave mold face to form a shape-retaining hydrophilic polymer layer. A very thin layer of opaque matter is deposited on the exposed polymer face and covered with a second layer of the monomer mixture, which is then polymerized under rotation to form, together with the above mentioned layers, the finished contact lens or front part of the eye prosthesis. The opaque material may simulate the iris, pupil, and/or sclera of an eye when the laminer product is ultimately swelled by contact with physiological saline solution prior to use as a soft contact lens or as a part of an artificial eye.

BACKGROUND OF THE INVENTION

This invention relates to improvements in soft contact lenses and articfical eyes made from hydrogels consisting essentially of water-swollen sparingly cross-linked hydrophilic polymers, and particularly to partly opaque ophthalmic device such as contact lenses and eye-prostheses.

The materials for the ophthalmic devices with which this invention is particularly concerned have been disclosed inu Pats. Nos. 2,976,576 and 3,220,960. A typical representative of the hydrophilic polymers suitable for the use

in making the ophthalmic devices is a copolymer of ethyleneglycol monomethacrylate with less than 2% of ethyleneglycol dimethacrylate. The hydrogels of the polymer are distinguished by their excellent transparency and lack of color.

The above mentioned method, using a two-stage polymerization casting in a rotating mold, has certain disadvantage in that the colored pattern, if created by hand, must be made from behind, the actual appearance thereof being visible only after removing the swollen article from the mold. Morevover, the pattern is to drawn on a concave surface and on a water-swollen hydrogel so that the pattern is sometimes blurred by diffusion of the ink. Although said disadvantages may be overcome by the skill of the worker, they nevertheless and tend to delay the work and increase the amount of waste.

It has been found that a very thin plan-parallel layer added to the concave surface of a ready made contact lens does not impair the quality of the lens in any way. Thus, the method of the invention consists in forming first a thin covering layer of the hydrophilic polymer on a regular surface of a smooth pad, e.g. on a polished glass plate. Such plan-parallel very thin layer may be easily mead by putting a drop of the initiated monomer mixture onto the pad and covering it with a smooth covering plate, e.g. a thin glass plate such as used for covering specimen for microscopical examination. Air bubbles are to be avoided. As soon as the access of the oxygen is excluded, the polymerization takes place rapidly. The covering plate is removed, if necessary after swelling the polymer in water or alcohol. The polymer layer dries rapidly when exposed to the atmosphere. Now, the colored pattern can be drawn in front view onto a planar surface so that the drawing and/or dyeing is very convenient and reliable. The pattern or a part of it may be also printed using a stamp or other printing die or stencil. Alternatively, a ready made pattern on a thin foil, e.g. a color film copy, may be laid onto the first polymer layer. Thereafter another drop of the initiated monomer mixture is put onto the pattern and covering layer, and a finished hydrogel contact lens or the front part of the artificial eye is pressed slightly thereon until the whole is firmly bound by the polymerized monomer mixture which has partly penetrated into the two hydrogel layers. The procedure is made easier if the hydrogel lens or the front part of the artificial eye is first planarized under at least partial dehydration, the lens or similar being pressed onto a smooth glass or metal surface heated above about 100° C. The dehydrated polymer becomes soft and plastic at about 120° C., but any amount of water contained therein decreases the softening temperature. The lens and the pad are then cooled down under the softening temperature so that the lens, after having been removed from the pad, is now planarized. It can be easily bonded to the covering layer with the colored pattern by a single drop of initiated monomer mixture. Finally, the whole is swelled, advantageously in water or in a physiologic solution, whereby the lens or the front part of the artificial eye returns to its original shape. The change of curvature caused by the thin covering layer and pattern is in most cases negligible. If necessary, the original lens may be a little more curved so that the change shifts the curvature to the desired optimum.

SUMMARY OF THE INVENTION

The invention resides in a new method for manufacturing colored soft hydrogel contact lenses or ophthalmic prostheses, having the colored pattern enclosed between at least two layers of soft, transparent hydrogel so that the dyestuff or pigment cannot get in contact with the eye or the eye-lid. The method makes possible to use